

# इंटरनेट

# मानक

## Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 6012 (1992): Method for measurement of coating thickness by eddy current [MTD 24: Corrosion Protection]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



BLANK PAGE



भारतीय मानक

भंवर धारा पद्धति द्वारा लेपन मोटाई का मापन

( पहला पुनरीक्षण )

*Indian Standard*

MEASUREMENT OF COATING THICKNESS  
BY EDDY CURRENT METHOD

( *First Revision* )

UDC 669-058 : 531-717-11 : 621-179-147

© BIS 1992

BUREAU OF INDIAN STANDARDS  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

## **FOREWORD**

This Indian Standard ( First Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Metallic and Non-metallic Finishes Sectional Committee, MTO 20 had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1970. In view of the method, being used very widely in the country, it was felt necessary to revise this standard. In this revision, the recommendations of the various brand names of apparatuses for measuring coating thickness have been deleted and the test method has been aligned with relevant International Standard.

In the preparation of this revision, assistance has been derived from ISO 2360-1982 Non-Conductive coatings on non-magnetic basis metals — measurement of coating thickness — Eddy current methods, published by International Organization for Standardization.

## *Indian Standard*

# MEASUREMENT OF COATING THICKNESS BY EDDY CURRENT METHOD

( *First Revision* )

### 1 SCOPE

**1.1** This standard specifies the method of using eddy current instruments for non-destructive measurements of the thickness of non-conductive coatings on non-magnetic basis metals.

**1.2** The method is applicable for measurements of the thickness of most oxide coatings produced by anodizing, but it is not applicable to all conversion coatings, some of which are too thin to be measured by this method ( see clause 7 ).

### 2 REFERENCE

**2.1** The Indian Standard IS 3203 : 1982 'Methods for testing local thickness of electroplated coatings (*first revision*)' is a necessary adjunct to this standard.

### 3 PRINCIPLE

**3.1** Eddy current instruments work on the principle that a high frequency electromagnetic field generated in the probe system of the instrument will produce eddy currents in a conductor upon which the probe is placed, and that the amplitude and phase of these currents is a function of the thickness of non-conductive coating present between the conductor and the probe.

### 4 FACTORS AFFECTING THE MEASURING ACCURACY

The following factors may affect the accuracy of measurements of coating thickness.

#### 4.1 Coating Thickness

**4.1.1** A measuring uncertainty is inherent in the method. For thin coatings, this measuring uncertainty ( in absolute terms ) is constant, independent of the coating thickness, and, for a single measurement, is at least  $0.5 \mu\text{m}$ . For coatings thicker than about  $25 \mu\text{m}$  this uncertainty is an approximately constant fraction of the coating thickness.

**4.1.2** If measuring coatings of thickness  $5 \mu\text{m}$  or less, it is advisable to take the average of several readings.

**4.1.3** It may be impossible to obtain the accuracy requirement specified in 7 with coatings of thickness less than  $3 \mu\text{m}$ .

#### 4.2 Electrical Properties of the Basis Metal

Measurements using eddy current instrument may be affected by the electrical conductivity of the basis metal, which is a function of the composition and heat treatment of the material. The influence of electrical conductivity on the measurement varies considerably with the make and type of instrument.

#### 4.3 Basis Metal Thickness

**4.3.1** For each instrument, there is a critical thickness of basis metal above which measurements may not be affected by an increase in thickness. Since this thickness depends on both the measuring frequency of the probe system and the electrical conductivity of the basis metal, its value should be determined experimentally, unless it is specified by the manufacturer.

**4.3.2** In general, for a given measuring frequency, the higher the conductivity of the basis metal, the smaller is its critical thickness. For a given basis metal, the higher the measuring frequency, the smaller is the critical thickness of the basis metal.

#### 4.4 Edge Effects

Eddy current instruments are sensitive to abrupt changes in the surface contour of the test specimen. Therefore, measurements made too near an edge or inside corner shall not be valid unless the instrument is specifically calibrated for such measurements.

#### 4.5 Curvature

Measurements are affected by the curvature of the test specimen. The influence of curvature varies considerably with the make and type of instrument, but always becomes more pronounced as the radius of curvature decreases. Measurements made on curved test specimens shall not, therefore be valid unless the instrument is specifically calibrated for such measurements.

## 4.6 Surface Roughness

**4.6.1** Measurements are influenced by the surface topography of the basis metal and of the coating. Rough surfaces may cause both systematic and random errors. The later may be reduced by making a greater number of measurements, each measurement being made at a different location.

**4.6.2** If the basis metal is rough, it is also necessary to check the zero of the instrument at several positions on a sample of the uncoated, rough, basis metal. If no similar uncoated basis metal is available, the coating on the test specimen shall be stripped with a solution which does not attack the basis metal.

## 4.7 Foreign Particles

The probes of eddy current instruments have to make physical contact with the test surface because these instruments are sensitive to foreign material that prevents intimate contact between the probe and surface of the coating. The probe tip should be checked for cleanliness.

## 4.8 Probe Pressure

The pressure with which the probe is applied to the test specimen affects the instrument readings and shall therefore be maintained constant. This may be achieved by the use of a suitable jig.

## 4.9 Positioning of the Probe

Tilting of the instrument probe shall change the instrument response; hence the probe should always be perpendicular to the test surface at the point of measurement. This may be achieved by the use of a suitable jig.

## 4.10 Deformation of Test Specimens

Test specimens with soft coatings or thin test specimens may be deformed by the probe. Valid measurements on such test specimens may be impossible or may be accomplished only with the use of special probes or fixtures.

## 4.11 Temperature of the Probe

Because a large change in the temperature affects the characteristics of the probe, it should be used under approximately the same temperature conditions as those used for calibration.

# 5 CALIBRATION OF INSTRUMENTS

## 5.1 General

Before use, each instrument shall be calibrated in accordance with the manufacturer's instructions, using suitable calibration standards, giving appropriate attention to the factors listed in 4 and to the procedures described in 6.

## 5.2 Calibration Standards

Calibration standards of known thickness are available either as foils or as coated standards.

### 5.2.1 Calibration Foils

**5.2.1.1** Calibration foils used for the calibration of eddy current instruments are generally made of suitable plastic materials.

They are advantageous for calibration on curved surfaces and are more readily available than coated standards.

**5.2.1.2** To prevent measurement errors, it is necessary to ensure that intimate contact is established between the foil and the substrate. Resilient foils shall be avoided, if possible.

Calibration foils are subject to indentation and shall, therefore, be replaced frequently.

### 5.2.2 Coated Standards

Coated standards consist of non-conductive coatings of known, uniform thickness permanently bonded to a substrate.

## 5.3 Verification

**5.3.1** The electrical properties of the basis metal of the calibration standards shall be similar to those of the basis metal of the test specimen. To conform their suitability, a comparison of the readings obtained with the basis metal of the uncoated calibration standard and that of the test specimen is recommended.

**5.3.2** If the basis metal thickness exceeds the critical thickness, as defined in 4.3, the thickness measurement is not affected by the thickness of the basis metal. If the critical thickness is not exceeded, the thickness of the basis metal for the test and for the calibration shall be the same, whenever possible. If this is impossible, back up the calibration standard or the test specimen with a sufficient thickness of metal of similar electrical properties to make the readings independent of the basis metal thickness. This may not be done if the basis metal is coated on both sides, or if there is any gap between the basis metal and the back-up metal.

**5.3.3** If the curvature of the coating to be measured is such as to preclude calibration on a flat surface, the curvature of the coated standard, or of the substrate on which the calibration foil is placed, shall be the same as that of the test specimen.

## **6 PROCEDURE**

### **6.1 General**

Operate each instrument in accordance with the manufacturer's instructions, giving appropriate attention to the factors listed in 4.

Check the calibration of the instrument at the test site, each time the instrument is put into service, and at frequent intervals during use (at least once per hour) to ensure proper performance.

The following precautions shall be observed.

### **6.2 Basis Metal Thickness**

Check whether the basis metal thickness exceed the critical thickness. If not, either use the back-up method described in 5.3.2 or make sure that the calibration has been carried out on a calibration standard having the same thickness and electrical properties as the test specimen.

### **6.3 Edge Effects**

Do not make measurements close to an edge, inside corner, etc, of a test specimen, unless

the validity of the calibration for such measurements has been demonstrated.

### **6.4 Curvature**

Do not make measurements on a curved surface of a test specimen, unless the validity of the calibration for such measurements has been demonstrated.

### **6.5 Number of Readings**

Because of normal instrument variability, it is necessary to take several readings at each position. Local variations in coating thickness may also require that a number of measurements be made in any given area; this applies particularly if the surface is rough.

### **6.6 Surface Cleanliness**

Before making measurements, remove any foreign matter, such as dirt, grease and corrosion products, from the surface without removing any coating materials.

## **7 ACCURACY REQUIREMENTS**

The instrument, its calibration, and its operation shall be such that the coating thickness may be determined to within 10 percent of its true thickness. If measuring coating thicknesses of less than 5  $\mu\text{m}$ , it is advisable to take the mean of several readings. It may be impossible to obtain this accuracy with coating of thickness less than 3  $\mu\text{m}$ .



### **Standard Mark**

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

**Bureau of Indian Standards**

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

**Copyright**

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

**Revision of Indian Standards**

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference:

Doc : No. MTD 20 ( 3716 )

**Amendments Issued Since Publication**

Amend No.	Date of Issue	Text Affected

**BUREAU OF INDIAN STANDARDS**

**Headquarters:**

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002  
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha  
( Common to all Offices )

**Regional Offices :**

	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	{ 331 01 31 331 13 75
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	{ 37 84 99, 37 85 61 37 86 26, 37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	{ 53 38 43, 53 16 40 53 23 84
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	{ 235 02 16, 235 04 42 235 15 19, 235 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri ( East ) BOMBAY 400093	{ 632 92 95, 632 78 58 632 78 91, 632 78 92
Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.	